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Large Hadron Collider
Magnet Division Procedure

Proc. No.: LHC-MAG-R-1031

Issue Date: Oct. 10, 2000

Rev. No.: E

Rev. Date: June 25, 2003

Class: Dipole
Title: LHC D1/D3 Dipole Shell Welding Assembly

- Prepared by: Signature on File
- LHC Project Engineer: Signature on File
- Cognizant Engineer: Signature on File
- Electrical Engineer: Signature on File
- Head, Magnet Production Group: Signature on File
- Q. A. Approval: Signature on File
- ES&H Review: Signature on File

REVISION RECORD

Rev. No.	Date	Page	Subject	Approval
A	10/10/00		Initial Release.	
B	3/25/03		Changes per ECN #MG2131	
C	4/21/03		Changes per ECN #MG2138	
D	5/15/03		Changes per ECN #MG2143	
E	6/25/03		Changes per ECN #MG2148	

1. Scope:

This specification describes the procedure for longitudinal seam welding of the LHC D1/D3 Dipole Cold Mass Assemblies.

2. Applicable Documents:

The following documents, of the issue in effect at the time of release for manufacture, form a part of this procedure to the extent specified herein:

RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
RHIC-MAG-Q-1000	Procedure For Control of Measurement Test Equipment
SMD-OPM-8.1.1.39	Operation of the LHC Shell Welding Fixture

BNL Drawings:

14010119	Assembly, LHC D1 Containment Assembly
14010487	Assembly, LHC D3 Containment Assembly
14010194	D1 Collaring Drawing
14010081	D3 Collaring Drawing

3. Requirements:

The Dipole Cold Mass Assembly shall be welded in accordance with this specification and associated drawings.

All welding must be performed by welders qualified in accordance with ASME Section IX.

3.1 Material/Equipment

25-1776.01-5 Shell Weld Fixture Stand Assembly
25-1782.05-5 Lifting Beam Assembly
25-1789.92-2 Lifting Clamp Assembly
25-1807.03-5 Lifting Beam Weldment Assembly (LHC Collared Coil Lifting Beam Assembly)
25-1782.01-5 LHC Cold Mass Lifting Beam Assembly
25-1807.01-5 Shell Lifting Fixture
25-1797.01-5 LHC Yoke Lifting Angle Assembly
25-1717.43-3 Lifting angle Yoke/Shell Assembly

3.2 Safety Precautions

3.2.1 Operators shall be trained by their cognizant technical supervisor and qualified in the operation of the required welding equipment.

3.2.2 No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.2.3 All lifting and handling operations requiring overhead crane operations shall be performed by holders of valid Safety Awareness Certificates and trained in the use of the lifting device by the Cognizant Engineer or Technical Supervisor.

3.2.4 Some of the electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES&H Standard.

3.2.5 Hypot and impulse testing pose a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point where the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

3.3 Procedure

3.3.1 LHC D3 Dipole Pre Shell Welding Electrical Tests

3.3.1.1 Measure coil temperature. Measure voltage drops across coil at 1 amp DC, following
RHIC-MAG-R-7320. Complete the measurements of inductance and quality factor (Q) following RHIC-MAG-R-7228.

3.3.1.2 Perform an ohmmeter check of the resistance between the two coils, following RHIC-MAG-R-7243. Verify that the resistance is at least 20 mega-ohms.

CAUTION

Be sure the "Hypot", yoke, and beam tube are grounded at all times. Failure to Observe this caution may result in electrocution.

3.3.1.3 Perform a coil-to-coil hypot check at 3 kV, following RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3.3.1.4 Electrically connect the main coil leads together.

3.3.1.5 Perform a hypot check between the main coils and the yoke at 5 kV, attaching the grounded lead of the Hypot tester to the yoke, quench protection resistors, and beam tube following RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3.3.1.5 Make sure that all entries in the traveler are filled out as indicated. Attach computer printouts of post assembly electrical test data to the traveler.

3.3.2 Load Cold Mass onto Fixture

3.3.2.1 Install yoke temperature sensors as shown on the collaring drawing. Pay out the sensor wire. Secure with foil tape as shown on the collaring drawing. Label temperature sensor wires with Left/Right and sensor serial number.

3.3.2.2 Set lower support rails of the welding fixture at their narrowest position.

3.3.2.3 Roll magnet CCW 90 degrees. The yoke midplane is in the vertical position.

3.3.2.4 Using straps, lift the magnet onto the shell welding fixture.

3.3.3 Shell Welding

3.3.3.1 Measure and record the shell lengths.

CAUTION

Be careful not to damage the diode temperature sensors which are fastened to the yoke. Also be sure to protect the temperature sensor leads which run along the loading flats of the laminations.

3.3.3.2 Place the right half-shell (as viewed from lead end) over the top of the yoke. Center it uniformly about the longest coil. Center it circumferentially relative to the yoke by measuring the height from the weld fixture base plate to the shell edges.

NOTE

Important! Make certain that the correct half-shell is installed as well as properly oriented by noting the locations of the fiducial holes in the shell. Refer to the yoke containment drawing for proper hole orientation.

3.3.3.3 Clamp the half-shell to the yoke by applying 212 psi maximum to the air cylinders. Again check the edge position relative to the platen surface, verifying that the half-shell is still circumferentially centered after it is fully clamped. Verify with .002 feeler gauges that no gap exists between yoke survey notches and the rails over the entire length.

3.3.3.4 Use c-clamps, located between the cylinders, to draw in the edges of the shell.

3.3.3.5 Perform resistance check of each yoke temperature sensor as noted in LHC-MAG-R-1051. Record results in traveler.

3.3.3.6 Manually tack weld the shell to the yoke using 12010441-03. Use two certified welders, with one welder on each side of the magnet, remaining in-step along the length, within approximately 6 inches. Complete tacks from center towards ends. Tack welds shall have root penetration but must not be over filled with filler wire such that they interfere with the machine root pass. Tack welds must be a minimum of ½ inch long and located at each clamp location.

3.3.3.7 Manually TIG weld a complete root pass on both sides simultaneously using 12010441-03. Use two certified welders, with one welder on each side of the magnet, remaining in-step along the length, within approximately 6 inches. Start at the lead end and progress to the non-lead end. Leave the last three inches at each end unwelded in order to slide on the end plates later.

3.3.3.8 Unclamp the yoke assembly and remove the air cylinder support assembly. Using 25-1782.01-5, lift the upper half shell, yoke and coil assembly and place it on the rotating supports with the lower half shell. Rotate 180^0 (the welded half-shell is now down).

3.3.3.9 Place the yoke assembly on support feet. At the shell hole locations, the tooling will fit through holes in the shell, directly engaging the yoke lamination survey flats.

3.3.3.10 Center the left (top) half-shell longitudinally with respect to the right (bottom) half-shell. Center it circumferentially relative to the right half-shell so that a uniform gap exists between the two half-shell edges. Be careful not to damage the temperature sensors or the temperature sensor wires. Make certain that the shell is oriented properly by observing the locations of the fiducial holes.

3.3.3.11 Clamp the assembly by applying 212 psi maximum to the air cylinders. Again check the gap between the half-shells and their longitudinally alignment. The clamping must not make the half-shell gap uneven.

3.3.3.12 Check the yoke assembly with .002 feeler stock for full contact with the fixture in all support locations.

3.3.3.13 Use the c-clamps, located between the cylinders to draw in the edges of the shell.

3.3.3.14 Perform resistance check of each yoke temperature sensor as noted in LHC-MAG-R-1051. Record results in traveler.

3.3.3.15 Have the weld shop supervisor inspect the magnet and the welding machine settings. Weld shop supervisor must sign traveler before second half shell is tack welded.

3.3.3.16 Tack weld the shell halves together using filler wire (P/N 12010441-03). Tacks shall be in the same location as the bottom shell tacks. Use two certified welders, with one welder on each side of the magnet, remaining in-step along the length, within approximately 6 inches. Leave the last three inches at each end unwelded in order to slide-in the end plate later.

3.3.3.17 Make manual TIG root passes on each longitudinal seam using filler wire (P/N 12010441-03). Use two certified welders, with one welder on each side of the magnet, remaining in-step along the length, within approximately 6 inches. Leave the last three inches at each end unwelded in order to slide-in the end plate later.

3.3.3.18 Have an authorized weld inspector inspect the root pass. Weld inspector must approve root pass and sign the traveler before any further welding is done.

3.3.3.19 Make a cover pass on each longitudinal seam by MIG welding using .035 in. filler wire (P/N 12010441-02). Use two certified welders, with one welder on each side of the magnet, remaining in-step along the length, within approximately 6 inches. Leave the last three inches at each end unwelded in order to slide-in the end plate later.

3.3.3.20 Have an authorized weld inspector inspect the completed seam weld. Weld inspector must sign the traveler.

3.3.3.21 Unclamp the assembly and remove the air cylinder support assembly.

3.3.3.22 After shell weld has cooled measure and record the shell lengths.

3.3.4 Quench heater termination

3.3.4.1 Install the quench heater mounting boards as shown on the assembly drawing.

3.3.4.2 Fold each heater over 14 gauge wire and solder as shown on the assembly drawing.

3.3.4.3 Install quench heater clamps as shown on the assembly drawing.

3.3.5 Electrical Testing

DANGER

Be sure the "Hypot", yoke, and beam tube are grounded at all times. Failure to observe this caution may result in electrocution.

3.3.5.1 Perform a coil-to-coil hypot check at 3 kV, following RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3.3.5.2 Electrically connect the main coil leads together.

3.3.5.3 Ground yoke, beam tube, and quench resistors together. Perform a hypot check between the main coils and ground at 5 kV, attaching the grounded lead of the hypot tester to the yoke/shell following RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3.3.5.4 Measure coil temperature. Measure voltage drops across coil at 1 amp DC, following RHIC-MAG-R-7320. Complete the measurements of inductance and quality factor (Q) following RHIC-MAG-R-7228.

3.3.5.5 Perform a hypot check between the yoke and each of the quench protection resistors at 2.5 kV attaching the grounded lead of the hypot tester to the yoke/shell following RHIC-MAG-R-7242.

NOTE

The leakage current must be less than 50 μa.

3.3.5.6 Perform a hypot check between the yoke and each of the quench protection resistors at 5.0 kV attaching the grounded lead of the hypot tester to the yoke/shell following RHIC-MAG-R-7242. Record the leakage.

3.3.5.7 Perform resistance test on each of two quench protection resistor circuits.

3.3.5.8 Electrical engineer to review electrical test data and sign off "OK to Proceed".

4 Quality Assurance Provisions:

4.1 The Quality Assurance provisions of this procedure require that all assembly and test operations be performed in accordance with the procedural instructions contained herein.

4.2 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

4.3 All discrepancies shall be identified and reported in accordance with RHIC-MAG-Q-1004.

5 Preparation for Delivery:

N/A